ONTARIO MINISTRY OF THE ENVIRONMENT

PHOSPHORUS RETENTION CAPABILITY OF GRANULAR SOILS ON THE PRECAMBRIAN SHIELD NORTH OF KINGSTON

1976

by

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Technical Support Section

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1977

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ABSTRACT

Tests were performed on soil samples taken from 45 borrow pits which were considered to be the source of granular material to be imported for the construction of raised septic tank tile beds in the Precambrian Shield north of Kingston. In addition, samples from 5 proposed subdivisions located on recreational lakes were tested. The pits selected were those normally used to provide fill material for tile bed systems on lakes which were considered likely to be sensitive to nutrient input from shoreline development.

The 1976 soil testing program was an extension of the 1975 program and confirmed the conclusions of that program:

1. Within the area tested the soil mantle generally has a good phosphate retention capability but it is limited by the amount of soil present.
2. Present material being used for raised tile beds comes from major sand/gravel pits and is too coarse. It has a poor phosphate retention capability.
3. Suitable material is available at most major deposit sites. Generally it is the top two - three feet of material which constitutes the A & B soil horizons and is characteristically light brown in colour.

The report recommends:

1. That only the materials having a good phosphate retention capability be used in raised tile beds for septic tank systems on lakes judged to be sensitive to nutrient inputs.
2. That a 100-foot setback for raised disposal systems be maintained on all sensitive lakes in the Southeastern Region.
3. That the Health Units and pit operators be advised of the location of suitable material and how it can be recognized.
4. That the Health Units be advised by April 1, 1977 of all lakes where these additional precautions are recommended.

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BACKGROUND

Historical data on water quality in recreational lakes is sparse and incomplete. However, it appears that there is a relationship between density of development on the lakes and deterioration in water quality. Effects of removal of vegetation, disturbance of the soil by construction of roads, buildings and services, the "improved" drainage by accelerating runoff from swamps and natural settling basins, improperly designed or improperly operating waste disposal systems and lakeside human activities all have some adverse effect on water quality in the lakes. The extent to which each activity is responsible has not been determined and will vary with local conditions.

A joint MOE/MNR Regional Recreational Lakes Committee was formed in 1974 in the Southeastern Region. This Committee recommended a number of lakes for water quality surveys, based on a number of factors including reported deterioration in water quality, importance of sport fishery, and pressures for development. Data has been collected on 110 lakes to permit an assessment of the lake capacity for development using the formula developed by Dillon(1) and the assessment of the results will be completed during 1977.

(1) Dillon, P.J. - A manual for calculating the capacity of a lake for development MOE - March 1975

A nutrient (phosphate) balance is being prepared for each lake. This is an estimate of the nutrient input from the atmosphere, from the land in the lake drainage basin and from the lake shore development. The nutrient levels in the lake are not only dependent on the nutrients coming in but also on the size and shape of the lake and the volume of the water flowing through it. A level of algal growth can be calculated resulting from the nutrient concentration. This is directly related to water clarity and water quality. If the calculated algal level agrees closely with that actually in existence in the lake, this is verification of the calculation and an estimate can be made of the amount of development the lake can sustain to maintain an acceptable level of water quality. Lakes vary greatly in their susceptibility to nutrient input. For example, headwater lakes are sensitive as they have less water flowing through them and there are no upstream lakes to act as nutrient traps.

The joint MOE/MNR Regional Committee recommended that a number of precautionary measures be taken for new development on all recreational waters in the Southeastern Region. This is being implemented only on those lakes where there is concern over maintaining an adequate water quality for recreation and where this concern can be substantiated by measurements and calculations. The additional protective

measures recommended are:

a) Setback of 100 feet as a buffer zone for the cottage and waste disposal system;

b) Preservation of the natural vegetation between the cottage and the lake in the buffer zone;

c) The use of the tile bed with selected material with a good phosphate retention capability and the use of a syphon or pump to provide an even distribution of septic tank effluent to the tile bed.

The proposal put forward by the joint committee for engineered tile bed systems combined with a 100-foot setback requirement for the primary structure (cottage) and waste disposal facility is intended as a total package for limiting phosphorus export from a cottage lot to sensitive recreational lakes. The tile bed system would be designed to ensure nutrient containment of the domestic waste and the 100-foot buffer zone is intended primarily to limit the nutrient export associated with surface drainage, (ie. roof runoff, roads, parking space and soils disturbed during construction of a building and waste disposal facilities). As a secondary consideration, a 100-foot buffer zone of undisturbed soil mantle would provide an added margin of protection in the form of phosphorus retention for nutrients which might leave the tile bed.

Tests to determine the phosphorus retention capability of soil were conducted in 1975[2] on a limited number of lots on sensitive recreational lakes and on pits from which material would be taken for the construction of raised tile beds. These were all located in the Precambrian Shield. The results indicated that soil on the shoreline lots generally has a reasonable phosphate retention capability. The main limitation is shallow depth of soil. The results indicate that the tile beds in the area studied should be setback 100 feet from sensitive lakes.

Studies by Brandes[3] indicate that the most significant place for phosphorus retention is in the top layers of soil under the tile in septic tank tile bed systems. Calculations[2] show that if this material had a P retention capability of 6 mg/100 grams of soil and 3 feet of depth below the tile, this material would be capable of retaining phosphates from the waste disposal system of a seasonal use cottage for 25 years. Additional retention capability in the buffer zone would be significant, but would depend on specific test conditions.

The testing of borrow pits in 1975 indicated that generally the pit material is too coarse and has a poor phosphate retention capability for use for raised tile beds on lots with a limited depth of soil. In the area tested, there was

(2) Phosphorus retention capability of granular soils on a portion of Precambrian Shield - Ministry of the Environment, Southeastern Region, 1975.

(3) Brandes, M., Studies on Subsurface Movement of Effluent from Private Sewage Disposal Systems Using Radioactive and Dye Tracers Part 2, 1973/74; Pollution Control Branch, Ontario Ministry of Environment, 1975.

suitable material overlying the main pit deposits. The phosphate retention capability of soil depends on its chemical composition. It was found that in granular material the sesqui oxides deposited in the B soil horizon have the best capability (generally the top two feet under the top soil).

GENERAL

The 1975 report[2] recommended that the sampling program be extended in 1976 to provide data on all borrow pits from which material is being used for tile beds on known sensitive lakes. The sampling procedures and laboratory tests[4] used were those outlined in the 1975 report. Some of the laboratory procedures however were changed and further changes are recommended for implementation in 1977. Details are included at Annex F.

One hundred and thirty-five soil samples were collected and analyzed during 1976. One hundred and eighteen samples were from borrow pits used to obtain material for raised tile beds in areas where there was insufficient soil. In all, forty-five borrow pits were examined and have been classified as follows:

Pits containing good quantities of material with a good phosphate retention capability - 3

Pits containing some material with an acceptable phosphate retention capability - 26

(4) Chemical analyses for evaluation of soils adsorption properties - Research paper #S2040, Applied Science Section, Pollution Control Planning Branch MOE, October 1974

Pits which are judged not to have a supply of material with an acceptable phosphate retention capability - 16

TOTAL 45

Shoreline soil samples from six lakes were examined. These samples show a good phosphate retention capability, the main difficulty being the lack of an adequate depth of soil for proper treatment. Details of soil sample results at both pits and lakes are contained as Annex B.

The location of the area covered by the survey is shown on the map as Annex C. The pits in the case of some of the lakes in the eastern part of the survey area are located some distance from the lakes they serve. This is caused by a shortage of suitable material in the vicinity. For example, the major pits serving Otty Lake are located at a distance of some 20 miles. The location of the borrow pits are shown on the map of Leeds and Lanark Counties at Annex D and the map of Frontenac County at Annex E.

CONCLUSIONS

1. The bulk of the granular material in most pits had a low percentage of fines and had a poor phosphorus retention capability. A supply of granular material with a phosphate retention capability of 6 mg/100 g. of soil is available in one-half of the borrow pits examined.

2. The suitable material available in the pits is generally limited to the top three feet and constitutes the A and B soil horizons. The boundary between the B and C horizons can usually be recognized by the brown colour of the B horizon resulting from the presence of iron oxides (limonite). The C horizon or zone which is unaltered by percolating surface waters generally has a poor phosphate retention capability. It is generally characterized by a grey colour and a lack of ferric iron stains.

RECOMMENDATIONS

1. That only the materials having a good phosphate retention capability be used in raised tile beds for septic tank systems on lakes judged to be sensitive to nutrient inputs.
2. That a 100-foot setback for raised disposal systems be maintained on all sensitive lakes in the Southeastern Region.
3. That the Health Units and pit operators be advised of the location of suitable material and how it can be recognized.
4. That the Health Units be advised by April 1, 1977 of all lakes where these additional precautions are recommended.

BIBLIOGRAPHY

1. Dillon, P.J., "A Manual for Calculating the Capacity of a Lake for Development" - Ministry of the Environment - March, 1975.

2. Aitkens, D.F., "Phosphorus Retention Capability of Granular Soils on a Portion of the Precambrian Shield", Ministry of the Environment, Southeastern Region, 1975.

3. Brandes, M., "Studies on Subsurface Movement of Effluent from Private Sewage Disposal Systems Using Radioactive and Dye Tracers Part 2, 1973/74", Pollution Control Branch, Ontario Ministry of the Environment, 1975.

4. Zarnett, G., "Chemical Analysis for Evaluation of Soil Adsorption Properties", Research Paper No. S2040, Applied Sciences Section, Pollution Control Planning Branch, Ministry of the Environment, October 1974.

ANNEX A

BORROW PIT CLASSIFICATION

MATERIAL CLASS

1. Good P retention capability - generally greater than 7 mg/100 g. Generally uniform results.
2. Acceptable P retention - generally greater than 6 mg/100 g. (Justification for this figure is contained in reference (2)).
3. Marginally acceptable P retention - generally greater than 5 mg/100 g.
4. Not acceptable - generally less than 5 mg/100 g.

QUANTITY OF MATERIAL (Based on size of pit and depth of soil with good P retention capability)

1. Good supply.
2. Moderate supply.
3. Limited supply.
4. Insuffient proven supply or unknown.

SAMPLING

1. Adequate sampling.
2. Limited sampling.
3. Inadequate.

CLASSIFICATION

	Class A Good (Minimum Acceptable)	Class B Acceptable (Minimum Acceptable)	Class C Not Suitable (Any one of the following ratings)
Material	2	3	4
Quantity	1	3	4
Sampling	1	2	3

NO.[1]	LAKE	PIT[2]	MATERIAL CLASS	QUANTITY	SAMPLING	CLASS
1	Buck	Norman	1	3	1	B
2	Buck	German (Hutchings)	2	3	1	B
3	Devil	Turnbull	3	2	1	B
4	Upper Rideau	Tracey	2	2	1	B
5	Upper Rideau	Westport Pit	1	3	2	B
6	Upper Rideau	The Stream	4	3		C
7	Upper Rideau	Soft Sand	4	3		C
8	Upper Rideau	Hutchings	1	2	3	C
9	Bobs	Hickey	4			C
10	Sharbot	Moss	1	1	1	A
11	Sharbot	Graydon Gray	1	1	1	A
12	Sharbot	Harold Gray	1	2	2	B
13	Otty	McDonald Cors. (W.Hall)	2	2	1	B
14	Otty	Watson Cors. (W.Hall)	3	2	1	B
15	Otty	McMunn	3	2	1	B
16	Otty	W.J.Orser	3	3	2	B
17	Crosby	Highway	3	2	2	B
18	Crosby	Ernie Richie (Hutchings)	4			C
19	Crosby	Fagin (Hutchings)	4			C
20	Big Rideau	Riley	4			C
21	Big Rideau	Sheffield (Lyons)	2	2	1	B
22	Loon & Newboro	Taylor (Hutchings)	4			C
23	Wolfe	McCarthy Bros. (Hutchings)	2	2	1	B
24	Kennebec, Buck, Big Clear, Bull,	Gendron (Veley)	2	2	1	B
25	Horseshoe, Garrison	Deline (Veley)	1	2	2	B
26	Charleston	Halliday Bay	4			C
27	Charleston	Gamble	1	1	1	A
28	Charleston	Sweets Cors.	1	3	2	B
29	Charleston	Green	1	2	1	B
30	Charleston	Kelsey #1	4			C

(1) Pits are plotted by number on maps at Annexes D & E.
(2) (Contractor using pit shown in brackets where known).

NO.[1]	LAKE	PIT[2]	MATERIAL CLASS	QUANTITY	SAMPLING	CLASS
31	Charleston	Kelsey #2	4			C
32	Charleston	Kelsey #3	1	2	1	B
33	Charleston	Williams (Avery)	3	3	2	B
34	Cranberry & Dog	G. Knapp	4			C
35	Knowlton	Richardson	4	2		C
36	Knowlton	Holleford Rd.	4	3		C
37	Knowlton	F. Schauf	1	2	2	B
38	Knowlton	D. Clarke	1	2	1	B
39	Knowlton	W.E.Rose	1	3	1	B
40	Canoe, Desert Thirteen & Fourteen	Young	4	1	2	C
41	Island, White, Thirty Island	E.Orser	3	3	2	B
42		Power Line	1	2	1	B
43		G. Davy	1	2	2	B
44	Beaver	Salmon River			3	C
45	Beaver	Simms	1	2	1	B

ANNEX B
SOIL SAMPLES TAKEN IN 1976
PHOSPHORUS RETENTION CAPABILITY OF GRANULAR SOILS

PLE BER	LAKE	SUB.* or PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTIO Retested mg/100 g See notes 2 & 3
1	Thanet	Sub.	L34	48.9	89.6	1'	Red, brown sandy loam	8.06 (6.5)	
2	Thanet	Sub.	L80	25.34	75.15	1'	Red, brown sandy loam	20.9 (20.14)	21.4 (20.45)
3	Thanet	Sub.	L43	32.48	83.44		" " " "	10.1 (10.47)	15.0 (15.3)
4	Thanet	Sub.	L2	34.17	91.20	2'	" " " "	22.2 (11.36	15.8 (10.36)
5	Big Rideau	Sub.	L26	35.0	70.9	1½'	" " " "	10.3 (13.53)	13.2 (12.88)
6	Buck Lake	Pit #1	G	21.8	68.1	1'	Brown sandy silt	15.8	16.2
7	Buck Lake	Pit #1	C	25.9	92.1	57"	Brown sandy topsoil 9" Fine brown silty sand 48"	8.0 (6.19)	
8	"	Pit #1	G	22.7	78.8	10"	Brown sandy topsoil Sandy loam	14.2	19.2
9	"	Pit #1	G	20.8	80.4	2'	Yellow brown medium Fine sand (same face as 6008)	4.02 (4.36)	
0	Devil Lake	Pit #3	G	2.63	27.9	2'	Medium brown sand	6.6 (5.27)	
1	"	Pit #3	C	16.42	81.47	52"	Topsoil removed, med. brown sand 10" Light brown sand med. to fine 42"	5.4 (5.26)	

IPLE IBER	LAKE	SUB.* OR PIT (*Subdivision)	TYPE (See note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTIO Retested mg/100 g See notes 2 & 3
.2	Devil Lake	Pit #3	C	2.53	17.73	78"	Topsoil 13", red brown coarse sand 43", grey silty sand	4.6 (4.05)	
.3	"	Pit #3	G	3.4	21.6	30"	Red brown sand (same face as 6012)	1.5 (6.43)	
.4	Canoe, Thirteen Island, etc.,	Pit #40	C	6.42	66.12	89"	Dark brown sand 3", med brown sand 58", grey sand 28", brown streaks	4.6 (4.93)	
.5	"	"	G	6.35	57.4	2'	Red brown sand (same face as 6014)	7.9 (8.24)	
6	"	"	G	1.9	11.4	2'	Red brown coarse sand	1.06 (1.09)	
7	"	"	G	5.24	34.84	2'	Red brown sand	3.0 (2.8)	
8	Upper Rideau	Pit #4	G	2.7	43.76	5'	Light brown coarse sand	5.46 (3.43)	
9	" (Same face as 6018)	Pit #4	G	10.24	87.26	2'	" " "	8.9 (8.5)	
0	Upper Rideau	Pit #5	G	19.97	51.75	4½'	Dark brown sandy loam	8.2 (7.77)	
1	" (same face 6020)	Pit #5	G	1.57	64.4	8'	Fine light brown sand	7.15 (8.05)	
2	Upper Rideau	Pit #6	G	10.49	42.73	4'	Grey brown sandy soil glacial till	6.37 (6.4)	
3	"	Pit #6	G	10.75	27.51	6'	Red brown sandy soil	2.3 (2.07)	

PLE BER	LAKE	SUB * OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD INDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTIO Retested mg/100 g See notes 2 & 3
4	Upper Rideau	Pit #7	G	2.04	17.24	4'	Red brown medium sand	1.75 (1.7)	
5	Bobs Lake	Pit #9	G	4.46	57.19	2'	Red brown sandy soil	3.6 (3.65)	
6	"	Pit #9	G	3.9	38.24	3'	Red brown sandy silt loam	3.5	
7	Sharbot Lake	Pit #10	G	13.5	60.65	1'	" " " " "	15.1	
8	Sharbot Lake	Pit #11	G	13.45	66.28	2'	Red brown sand	8.6	
9	"	"	G	16.60	67.78	Top 10"	Dark brown sandy loam	7.4	
0	"	"	G	9.47	70.40	5'	Light grey-brown sandy soil	5.4 (2.2)	2.7 (2.57)
1	Sharbot Lake	Pit #12	G	46.72	96.29	3'	Fine light brown sandy soil	7.2	Comb. 2.36
2	"	"	C	30.23	87.03	8'4" total	Fine sand-silt soil brown	8.9	
3	Otty Lake	Pit #13	G	19.11	80.19	1'	Red brown sandy soil	7.8	7.2 (8.05
4	"	"	G	9.89	58.36	2'	Fine light brown-grey sand	2.6	2.8 (4.35
5	"	"	C	13.86	61.46	80"	18" dark brown topsoil (A) 30" med. brown sand (B) 32" grey sand (C)	10.6	5.0 (4.78
6	"	"	G	6.08	33.86	3'	Grey brown sand	2.5	3.2
7	"	Pit #14	G	31.66	85.79	3'	Red brown fine sand	5.7	4.0 (5.76
8	"	Pit #14	C	13.35	57.37	4'	8" dark brown topsoil (A) 30" light brown sandy soil (B) Grey sand and gravel (C)	4.6 (4.5)	

IPLE IBER	LAKE	SUB * OR PIT (*Subdivision)	TYPE (see note 1	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTION Retested mg/100 g See notes 2 & 3
9	Big Rideau	Pit #20	G	14.61	50.75	2'	Topsoil removed Red brown med. sand	3.5	
0	Big Rideau	Pit #21	C	8.87	42.45	5'	7" dark brown topsoil (A) 40" red brown sandy soil (B) Grey brown coarse sandy gravel (C)	3.1	4.8
1	" (same face as 6040)	Pit #21	G	15.30	50.58	2'	Red brown med. sandy soil	12.3	38.9
2	Buck Lake	Pit #2	G	5.66	19.49	4'	Coarse brown sandy soil	2.0	
3	" (same face as 6042)	Pit #2	G	14.0	54.5	1'	Red brown fine sandy soil	13.2	
4	Loon & Newboro Lakes	Pit #22	G	2.5	55.0	1'	Coarse brown sand	4.8	
5	Wolfe Lake	Pit #23	G	19.0	99.5	4'	Fine brown sand	5.0 (5.98)	6.22
6	"	Pit #23	G	7.7	49.2	1'	Red brown fine sand	4.6	
7	Big Crosby	Pit #18	G	1.7	23.7	3'	Red brown med. sandy soil	2.3	
8	Big Crosby	Pit #19	C	6.0	32.3	6'	12" dark brown topsoil (A) 23" red brown sandy loam (B) Grey brown sandy soil (C)	2.9	
9	" (same face as 6048)	Pit #19	G	8.79	38.37	2'	Red brown sandy loam	3.1 (3.14)	

IPLE IBER	LAKE	SUB* OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTION Retested mg/100 g See notes 2 & 3
0	Upper Rideau	Pit #8	G	19.2	82.5	1'	Red brown fine sandy soil	8.1	
1	Kennebec	Pit #24	G	29.6	95.0	1'	Red brown sandy soil	9.4	
2	"	Pit #24	G	16.5	70.0	1'	" " " "	6.4	
3	Kennebec	Pit #25	G	6.3	45.1	1.5'	Light brown sandy soil	11.5	15.8
4	Limerick	Sub.	G L1	45.92	75.76	18"	Dark brown sandy loam	20.5 (11.32)	
5	"	Sub.	G L22	13.75	46.79	30"	Grey-brown sandy soil	4.4 (4.2)	
6	Otty	Pit #15	G	16.95	74.02	3'	Med. brown fine sand	5.7 (5.7)	
7	"	Pit #15	G	3.58	19.69	1'	Coarse grey brown sand	2.2 (1.88)	
8	"	Pit #15	G	16.29	70.04	16"	Red brown fine sandy loam	7.1	
9	Otty	Pit #16	G	4.68	47.94	3'	Grey streaks in brown fine sandy loam	3.2	
0	"	Pit #16	G	7.56	56.43	4'	Dark red brown fine sandy loam	5.4	
1	"	Pit #16	G	4.84	44.69	1'	Red brown with grey streaks fine sand	5.5	
2	Crosby	Pit #17	G	12.08	58.76	2'	Red brown fine sandy loam	7.2	
3	" (same face as 6062)	Pit #17	C	11.26	52.15	86"	Grey brown sandy soil	4.0	

PLE BER	LAKE	SUB* OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 mg See notes 2 & 3	P RETENTION Retested mg/100 g See notes 2 & 3
4	Ontario (Massassauga Estates sewage treatment location)	Sub.	G	17.54	39.97	10"	Dark brown topsoil Some B horizon Too much limestone Bedrock to dig deeper	13.3	
5	Ontario (Pr.Edward Cty.)	Pit	G	26.41	66.58	7'	Light fine grey brown sandy soil	7.6	
6	"	Pit	G	4.25	47.64	30"	Reddish brown coarse sandy soil	3.6	
7	Black Donald, 100' from shore	Sub.	G	23.72	57.14	1'	Red brown sandy loam	10.00	
8	300' from shore	Sub.	G	16.91	42.37	1½'	Red brown sandy loam	6.1	
9	Big Crosby (T-75032)	Sub.	L4	17.6	41.1	1½'	Med. red brown sandy soil - fine	7.6	
0	"	Sub.	L15	21.9	56.9	1½'	Dark brown sandy loamy soil	6.7	
1	Charleston	Pit #26	G	4.4	19.7	4'	Reddish brown sandy soil	2.6	
2	Charleston	Pit #27	G	5.25	59.45	24"	Light brown sandy soil	5.1	
3	"	Pit #27	G	14.16	68.8	12"	Light brown sandy soil	6.6 sieved	9.1 not sieved
4	"	Pit #27	G	21.98	83.26	30"	Grey-brown sandy soil	8.9	
5	"	Pit #27	C	12.52	71.03	6'	Light brown sandy soil	9.8 (8.45)	3.4 (3.34) Comb.4.82
6	Charleston	Pit #28	C	18.58	87.90	1'8"	Brown sandy loam	16.3	

IPLE IBER	LAKE	SUB* OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTION Retested mg/100 g See notes 2 & 3
'7	Charleston	Pit #28	G	16.32	81.34	1½'	Light brown sandy soil	9.8	
'8	Charleston	Pit #29	G	10.92	35.88	1'	Red brown med. sand	2.9 sieved	7.7 not sieved
'9	"	Pit #29	G	6.85	35.68	1½'	" " " "	8.3 sieved	11.2 not sieved
0	Charleston	Pit #30	G	2.09	23.07	4'	Med. coarse sand and clay mixture	1.6	
1	"	Pit #31	G	7.52	35.18	1'	Dark brown sandy soil	3.2	
2	"	Pit #32	G	14.57	79.33	2'	Light brown sandy soil	8.7	
3	Dickey Block "B1"	Sub.	LG	40.1	71.3	1'	Red brown sandy loamy soil	11.5	
4	Dickey	Sub.	LG	32.2	61.0	1'	Dark red brown sandy loam	15.6	
5	"	Sub.	LG	43.5	80.2	1'	Light red brown sandy loam	10.3	
6	Cranberry & Dog	Pit #34	C	2.8	27.9	8" A Horizon 6½' B Horizon 16" C Horizon	Dark brown med. sand	1.6	
7	"	Pit #34	G	1.8	33.2	4'	Med. brown sandy soil	2.7	
8	Otty Lake	Pit #13	G	11.01	68.34	2'	Dark brown sandy soil	7.1	
9	"	Pit #13	G	3.24	22.79	3'	Light grey-brown sandy soil	4.2	1.4

PLE BER	LAKE	SUB* OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTION Retested mg/100 g See notes 2 & 3
0	Otty Lake (same face as 6089)	Pit #13	G	12.35	53.09	1'	Dark brown sandy loam	6.8	10.4
1	"	Pit #13	G	8.60	29.63	18"	Dark brown sandy soil (Topsoil)	49.3 (40.58)	11.4 17.4
2	"	Pit #14	G	19.69	81.35	1'	Light brown sandy soil	9.3	
3	"	Pit #15	G	6.98	59.96	2'	Med. brown sandy soil	5.4	
4	Charleston	Pit #33	G	13.5	36.8	1'	Red brown coarse sandy soil	5.7	
5	"	Pit #33	G	7.7	60.9	2'	Grey brown sandy soil	2.2	2.76
6	Knowlton	Pit #35	G	3.1	26.4	2'	Reddish brown sandy soil	2.6	
7	"	Pit #35	G	1.6	34.0	2'	Red brown medium sand	4.4	
8	"	Pit #36	G	1.0	22.6	5'	Light grey brown medium sand	3.9	
9	"	Pit #37	G	25.1	86.9	2½'	Red brown fine sand	9.0	
0	"	Pit #38	G	0.1	50.2	2'	Grey brown red sand	7.2	
1	"	Pit #38	G	2.9	68.1	1'	Red brown fine sand	12.6	
2	"	Pit #39	G	24.0	93.5	2'	Med. brown fine sand	6.3	
3	"	Pit #39	G	15.2	95.9	1'	Med brown fine sand	13.7	

ᴍPLE ᴍBER	LAKE	SUB* OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTIO[N] Retested mg/100 g See notes 2 & 3
)4	Canoe, 13 Island,	Pit #41	G	10.2	78.1	off a pile	Grey-brown med. sandy soil	9.8	
)5	"	Pit #41	G	4.1	40.1	"	Light brown sandy soil	3.4	
)6	"	Pit #41	G	3.3	22.1	4'	Dark brown, coarse sand	1.6	
)7	"	Pit #42	G	1.3	60.9	3'	Light brown sandy soil	9.8	
)8	"	Pit #42	G	6.0	48.6	2'	Reddish-brown med. sand	18.7	
)9	"	Pit #42	G	1.2	32.7	2'	" " " "	12.6	
10	Canoe, 13 Island etc.	Pit #43	G	7.6	61.6	1'	Dark brown sandy loam	10.3	
11	"	Pit #43	G	11.0	83.5	1'	Light brown sandy soil (topsoil removed)	21.96	
12	Beaver	Pit #44	G	3.2	49.1	off a pile	Grey-brown sandy soil	7.0	
13	Beaver	Pit #45	G	2.5	23.8	3'	Dark brown med. sandy soil	2.12	
14	"	Pit #45	G	1.8	22.0	5'	Dark reddish-brown med. sandy soil	1.98	
15	"	Pit #45	G	7.7	28.1	4'	Dark brown sandy loam	4.2	
16	"	Pit #45	C	12.3	67.3	18" A 20" B 31" C	Med. brown sandy soil	12.45	
17	Kaminiskeg-Green Lake	Sub.	L13	12.3	46.4		Light brown med. sandy soil	10.07	

?LE 3ER	LAKE	SUB* OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTION Retested mg/100 g See notes 2 & 3
3	"	Sub.	L36	8.7	28.8		Light brown med. coarse sandy soil	6.9	
9	Charleston Lake	Pit #32	C	27.6	96.1	6'	Light brown fine sandy soil	17.78	
0	"	Pit #32	G	37.1	95.1	3'	Grey-brown fine sandy soil	12.17	
1	Big Rideau	Pit #21	C	7.0	57.3	6'	Light brown med. sandy soil	6.99	
2	"	Pit #21	G	6.0	56.4	3'	" " " " "	5.64	
3	Upper Rideau	Pit #7	G	1.3	34.3	2'	Reddish-brown med. sandy	4.90	
4	"	Pit #7	C	2.4	46.8	5'	" " " "	5.62	
5	Wolfe	Pit #23	C	12.1	77.0	5'	Light brown med. sandy soil	8.55	
6	"	Pit #23	G	8.3	73.5	1½'	" " " " "	15.95	
7	Devil Lake	Pit #3	G	1.4	15.6	3'	Dark grey-brown med. sandy soil	1.17	
8	"	Pit #3	C	3.2	21.4	5'	Light brown med. sandy soil	2.44	
9	Beaver	Pit #45	G	14.1	74.8	2'	Light reddish-brown sandy soil	16.6	
0	"	Pit #45	G	4.2	21.5	2'	" " " "	1.89	
1	"	Pit #45	C	10.0	50.3	8'	" " " "	6.64	

[M]PLE [NUM]BER	LAKE	SUB * OR PIT (*Subdivision)	TYPE (see note 1)	% PASSING 200 MESH	% PASSING 60 MESH	DEPTH	FIELD IDENTIFICATION	P RETENTION mg/100 g See notes 2 & 3	P RETENTIO[N] Retested mg/100 g See notes 2 & 3
[3]2	"	Pit #45	C	7.8	58.1	4'	" " " "	8.31	
[3]3	"	Pit #45	G	10.2	72.4	2'	" " " "	5.21	
[3]4	"	Pit #45	G	10.9	67.3	2'	" " " "	7.67	
[3]5	"	Pit #45	C	14.3	69.6	4'	" " " "	11.62	

[NOT]ES

L means the sample is from a Lot. The number following "L" is the Lot Number in the subdivision.
G means the sample is a grab sample from a specified depth.
C means the sample is a composite sample.
P. retention was remeasured if the results were questionable.
Numbers in brackets are Hewlett-Packard least squares fit.

ANNEX F

PHOSPHORUS RETENTION CAPABILITY OF GRANULAR SOILS ON THE PRECAMBRIAN SHIELD NORTH OF KINGSTON 1976

LABORATORY PROCEDURES

The laboratory tests used are those outlined in the 1975 report[(2)] and in the MOE Research Paper by G. Zarnett[(4)].

Testing of phosphorus (P) retention capability of the samples was based on the analysis of the soil fraction passing the 60 mesh sieve, rather than the 50 mesh sieve used in 1975. This change was made as 60 mesh is more easily converted to metric measurement.

The following changes are proposed in 1977:

(a) In order to reduce the laboratory effort required, all samples will be subject to coarse screening only, and the fraction passing #4 mesh will be tested for P retention. Only those samples where the permeability is in question will be subjected to a sieve analysis (i.e. samples with 25% or greater passing 200 mesh).

(b) Some inaccuracies occurred in plotting the data and estimating the best fit for the graph. A Hewlett-Packard calculator-plotter will be used to give a least squares fit for the data points. Some discrepancies occurred in 1976 as a result of estimating the best fit by eye.

(2) Op. Cit.
(4) Op. Cit.

A report on the phosphorus adsorption data by S.E. MacBeth, Chief of Lab & Air, Southeastern Region, follows:

PHOSPHORUS ADSORPTION DATA

A portion of the phosphorus adsorption data obtained from the summer Experience 76 Programme was recalculated with a Hewlett-Parkard calculator-plotter programmed to give a least squares fit of the data points and a calculated intercept on the y axis, corresponding to the reciprocal of the phosphorus adsorption. The summer results were obtained by manually plotting 5 data points per sample, then "eyeballing" a line of best fit to give the desired intercept.

The results from 50 data sets may be summarized as follows:

Agreement within 5%	22
Agreement within 10%	26
Agreement within 20%	32

The balance of 18 determinations showed a lack of agreement to the extent that further investigation was required. The main reason for this lack of agreement was a poorly defined curve where, consciously or unconsciously, the student would discount one or two data points while the calculator was programmed to give equal weight to all points. In at least

one case, the hand-drawn line was superior since one of the data points should not have been included according to the criteria listed later in this report.

In 6 of the 18 cases of discrepancy the adsorption was so high that the larger masses of soil taken could not give additional adsorption, i.e. the standard P solution was depleted by small amounts of soil. Repeating the determination with smaller masses of soil gave a well defined line.

In most of the other cases the soil had very low adsorption. This generated 5 closely grouped data points which did not define a slope or intercept. At low P adsorption it is not uncommon to have less depletion of P with a higher weight of soil for at least one of the five data points since, in cases of low adsorption a lack of homogeneity in the soil becomes an important factor in the amount of P adsorbed due to the limited number of adsorption sites present. It is unlikely that such soils could be accurately characterized for P adsorption but, the possibility exists that the use of larger amounts of soil might give better data points.

In order to minimize possible misinterpretation of data, certain criteria should be followed when interpreting and plotting data. The y data plotted are m/x which is the wt. of soil taken over the gms of phosphorus adsorbed from solution where m is arbitrarily chosen as 1, 2, 3, 5, 7 gm. The standard phosphorus solution used has .225 mg P in the

150 ml. aliquot used. Thus, m/x may be as high as where no adsorption occurs or as low as from 4.4 when all P is absorbed by 1 gm of soil to 30 when all P is adsorbed by 7 gm of soil. In practice, values of m/x greater than 40 (m = 3) are indicative of low adsorption and the calculated adsorption shold reflect this fact.

The x axis data plotted are values of 1/C where C is the concentration of phosphorus remaining in solution after the adsorbing soil has been removed. This may vary from 0.588 where no adsorption occurs to where complete adsorption occurs and C = 0. In practice a minimum of 0.02 mg/l P is always detected, giving a working upper limit of 50 for 1/C.

When P adsorption is high, it is possible to have two or even three of the higher weights taken give the same value for 1/C, i.e. the solution is depleted at a lower sample weight than the maximum chosen. In this case different, lower weights of sample should be taken to determine new points on the curve. The statement can be made that no data point should be used if 1/C is greater than 20, corresponding to a final solution concentration of P- 0.05 mg/l.

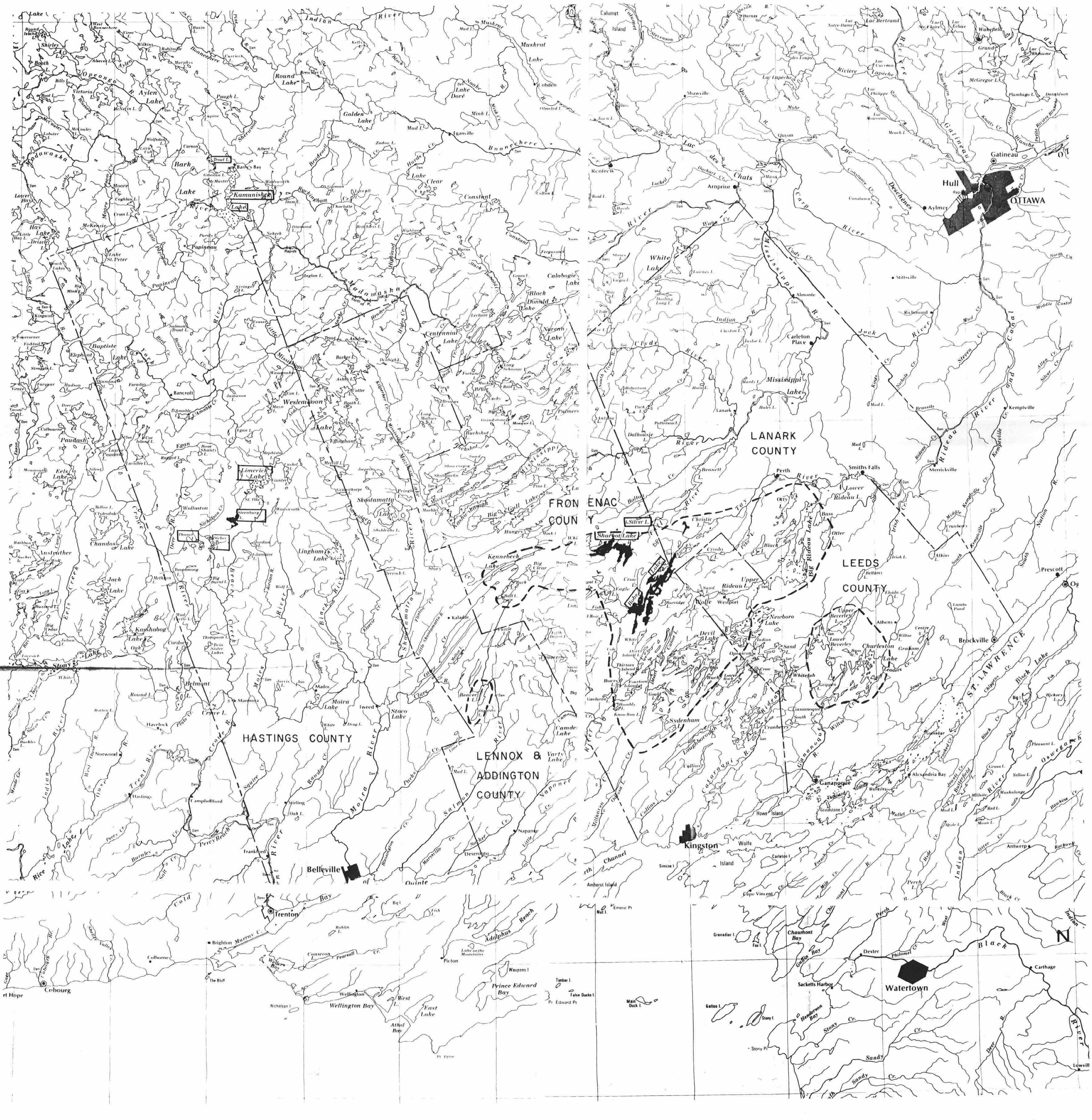
Since low values of 1/C represent low phosphorus adsorption, it is advisable to choose higher weights of soil, such that the final value of 1/C is greater than (arbitrarily) 2. This will eliminate graphs which contain 5 highly grouped

data points with no readily discernable slope or intercept (sample 6008).

The calculated intercept is that value of m/x for which 1/C is zero.

In physical terms, the reciprocal of m/x is the limiting phosphorus adsorption in mg P per gm of soil, as the concentration of phosphorus remaining in solution goes to extremely high levels (infinity).

This quantity x/mlin also known as Q is called the phosphorus adsorption capability of the soil.



LEGEND

LAKES WITH SOIL IN SUBDIVISIONS & BORROW PITS TESTED

LAKES WITH SOILS IN SUBDIVISIONS ONLY TESTED

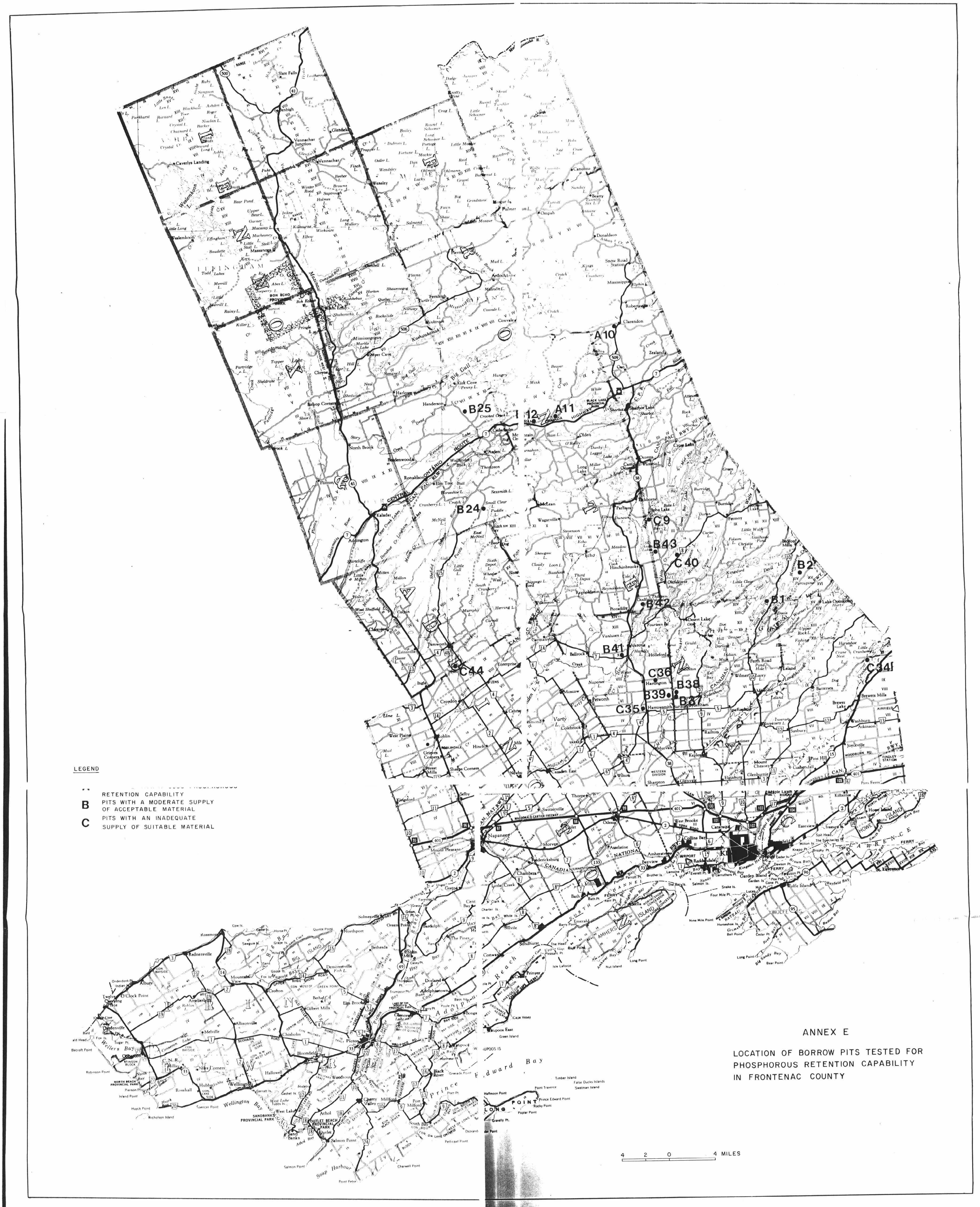
GENERAL AREAS SERVICED BY TESTED BORROW PITS

(SOIL TESTS CONDUCTED IN 1974 - 1976 INCL)

8 4 0 8 MILES

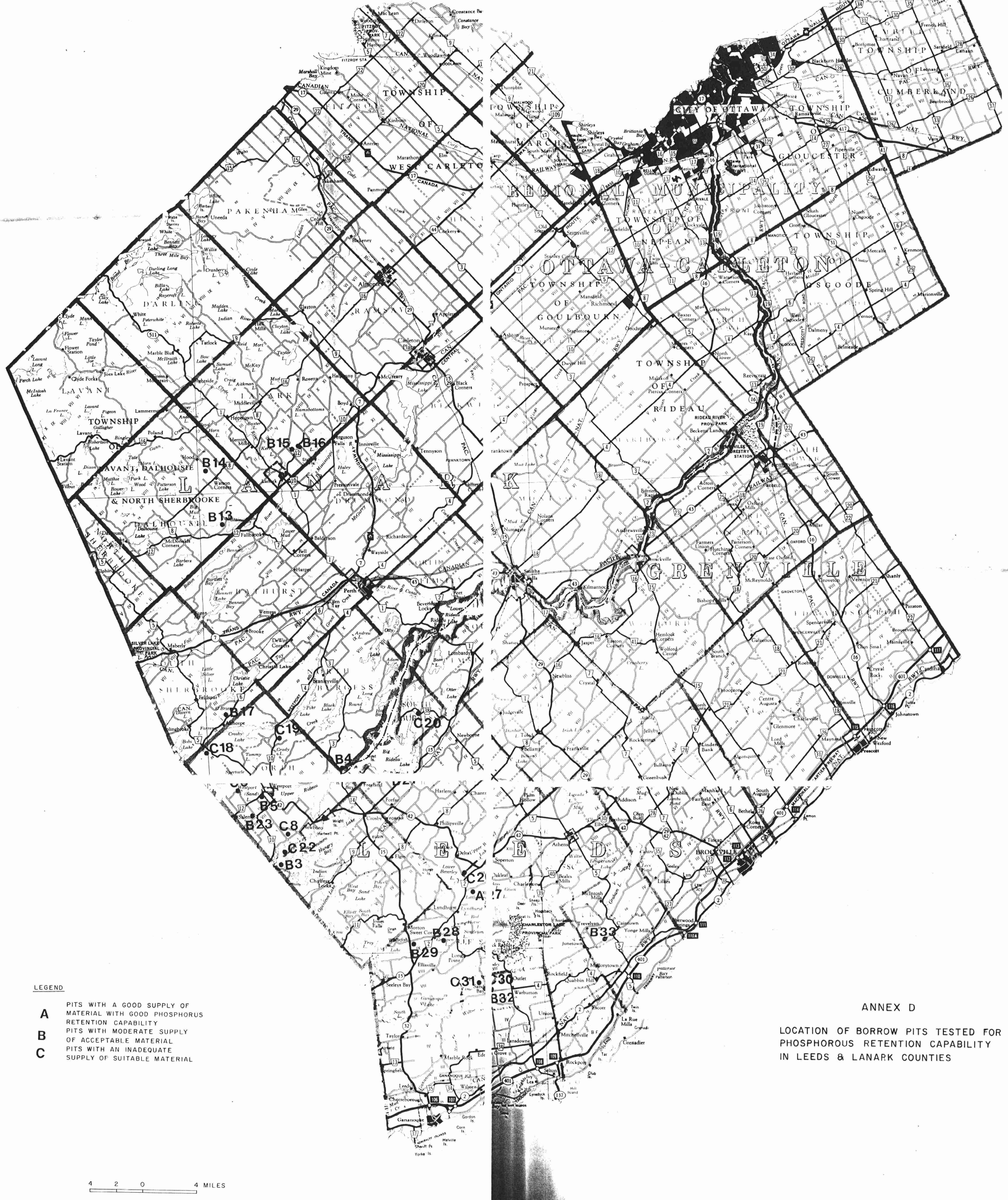
ANNEX C

PHOSPHOROUS RETENTION CAPABILITY OF GRANULAR SOILS ON THE PRECAMBRIAN SHIELD NORTH OF KINGSTON 1976



ANNEX E

LOCATION OF BORROW PITS TESTED FOR PHOSPHOROUS RETENTION CAPABILITY IN FRONTENAC COUNTY



LEGEND

A PITS WITH A GOOD SUPPLY OF MATERIAL WITH GOOD PHOSPHORUS RETENTION CAPABILITY

B PITS WITH MODERATE SUPPLY OF ACCEPTABLE MATERIAL

C PITS WITH AN INADEQUATE SUPPLY OF SUITABLE MATERIAL

ANNEX D

LOCATION OF BORROW PITS TESTED FOR PHOSPHOROUS RETENTION CAPABILITY IN LEEDS & LANARK COUNTIES

DATE DUE
